FINAL

WORK PLAN FOR GROUNDWATER FLOW AND TRANSPORT MODELING

Monsanto Soda Springs, Idaho Plant

REPORT

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July 9, 2012 **Project No. 913-1101-002.003.3A**

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1.0 INTRODUCTION

This Work Plan presents the regulatory framework, goals, and approach for conducting numerical groundwater flow and contaminant transport modeling at the Monsanto Soda Springs Idaho Plant (Plant) site. The Monsanto Soda Springs Plant (Plant) is located approximately one mile north of the City of Soda Springs, Caribou County, Idaho (Figure 1). This work is part of the Five-Year Review process.

The proposed modeling will focus on the transport of constituents of concern in groundwater and their discharge to surface water. The work will update previous groundwater modeling completed for the site in 1995 (Golder 1995) and updated as part of the 2003 Five-Year Review process (Golder 2008).

To address the updated conceptual model (as presented in the 2011 Summary Report [Golder 2012a]), a new groundwater flow and transport model is planned to support predictions of the estimated time for concentrations to decline below RGs at all points of compliance. The modeling will address transport of constituents of concern originating from source areas at the Plant to areas south and west of the Plant site. The model will incorporate:

- Updated groundwater flow system within improved understanding and simulation of fault behavior
- Updated plume concentration and migration observations
- Specific modeling of the transport of constituents of concern with respect to RGs
- Improved understanding of the timeframe to reach natural attenuation goals at points of compliance

This Work Plan is organized into the following sections:

- **Section 2** presents an overview of the hydrogeologic setting
- **Section 3** provides the regulatory framework for this study
- **Section 4** presents a summary of modeling goals
- **Section 5** presents the modeling approach
- **Section 6** presents the schedule
- **Section 7** is the closing
- **Section 8** provides references

2.0 OVERVIEW OF AREA HYDROGEOLOGY

The hydrogeology at the Monsanto Plant is presented in Golder Associates Inc. (Golder 1995) and updated by information presented in a response to Agency comments on the 2009 Summary Report of Groundwater Conditions at the Soda Springs Plant (Golder 2010). Regional groundwater flow is generally from north to south. The Blackfoot Reservoir, located about 12 miles north of the facility, is a known area of groundwater recharge to the southern portion of Soda Creek basin (Dion 1974). Groundwater flow paths in the Plant area are generally consistent with regional flow, with localized influence by faulting, pumping of the Plant's four production wells, and groundwater discharge to numerous springs and Soda Creek.

The primary hydrostratigraphic zones underlying the Monsanto Plant include the Upper Basalt Zone (UBZ) and the Lower Basalt Zone (LBZ). The principal aquifer is the UBZ, which extends to a depth of about 100 feet below ground surface (bgs) below the Plant. Depth to the water table ranges from 20 feet bgs in the northeast corner to 100 feet bgs in the center of the Plant. The UBZ consists of up to three permeable interflow zones designated $\gamma 3$, $\gamma 4$, and $\gamma 5$ that consist of cinders, broken and rubbly basalt, and sedimentary materials. The interflow zones are separated by lower-permeability basalt flows. Groundwater elevation data and pumping tests demonstrate a vertical hydraulic connection between the UBZ interflow zones (Golder 1995).

The UBZ and LBZ are broken into smaller regions (UBZ-1 through UBZ-4 and LBZ-1 through LBZ-4), based on hydrogeological controls and groundwater quality (Figures 2 and 3). Details pertaining to the breakdown of UBZ and LBZ regions are provided in Golder (1995). Wells and springs at and in the vicinity of the Plant are shown in Figures 2 and 3 for the Upper Basalt Zone (UBZ) and Lower Basalt Zone (LBZ), respectively.

Within the Plant area, the Monsanto Fault and Subsidiary Fault (Figure 2) are hinge faults that separate the UBZ into distinct zones because of offsetting of permeable interflow zones and dense, low permeability flow interiors (Golder 1995). The faults have been generally considered barriers to groundwater flow in the Plant area as a result of the fault offsets; however, recent water quality data from newly installed monitoring wells suggests that some groundwater flow and contaminant transport is occurring across the Subsidiary Fault and migrating to the southwest. The mechanisms for this are not well understood, but likely occur through a combination of groundwater flow within the damage zone of the fault and interconnection of offset permeable interflow zones. South of the Plant Fence Line, the offset on the faults decreases based on correlation of basalt flows and interflow zones between boreholes and geophysical surveys (Golder 1995, 2006, 2007). The decrease in offset south of the Fence Line appears to result in some degree hydraulic communication between UBZ regions across the faults.

The UBZ and LBZ are located within and constrained by the Bear River Valley graben, and north-south trending feature. The basin is bounded on the east by the Aspen Range, composed of Paleozoic sedimentary formations, and significant recharge to the UBZ occurs along and adjacent to the fault zone bounding the graben. A similar situation occurs to the west of the basin, where the Soda Spring Hills and Ninety Percent Range are uplifted fault blocks of Paleozoic formations. Significant upwelling of sodic water occurs along this mountain front southwest of the Plant site. Groundwater recharge from both of these areas to the UBZ will be considered in model development.

3.0 CURRENT CONDITIONS

The Plant is located approximately one mile north of the City of Soda Springs, Caribou County, Idaho (Figure 1). Monsanto conducted a Remedial Investigation/Feasibility Study (RI/FS) under an Administrative Order on Consent (AOC) with the United States Environmental Protection Agency (EPA). The purpose of the RI/FS (which began in 1991) was to determine the nature and extent of constituents at and near the Plant, including an investigation of groundwater quality.

3.1 Record of Decision

A Record of Decision (ROD) was signed by Monsanto and EPA (EPA 1997) that prescribes selected remedies for the affected environmental media at the site. For groundwater, the selected remedy is monitored natural attenuation with institutional controls to prevent human exposure to groundwater until groundwater quality improves to concentrations less than the remediation goals. This remedy was selected based on previous groundwater modeling results conducted as part of the RI/FS process that predict restoration of groundwater to concentrations below the remediation goals (Golder 1995).

The ROD established groundwater remediation goals for the constituents of concern: cadmium, fluoride, nitrate, selenium, and manganese. The remediation goals are the Maximum Contaminant Levels (MCLs) under the Safe Drinking Water Act for cadmium, fluoride, nitrate, and selenium, and a risk-based concentration for manganese, as shown in Table 3-1.

Table 3-1: Groundwater Remediation Goals for the Monsanto Plant

Parameter	Remediation Goal (mg/L)	Regulatory Source
Cadmium	0.005	Maximum Contaminant Level
Fluoride	4	Maximum Contaminant Level
Nitrate as NO_3/ Nitrate as N	44 /10	Maximum Contaminant Level
Selenium	0.05	Maximum Contaminant Level
Manganese	0.18	Risk-Based Concentration

There were no surface water remediation goals established under the ROD. For some parameters, surface water quality standards are different than the remediation goals (IDAPA 58.01.02.210).

3.2 Points of Compliance

The ROD established the points of compliance for remediation goal monitoring. Several modifications were made to the list of point of compliance wells, as described in Golder (1998), based on availability and accessibility of some wells. Based on the ROD and modifications to the ROD, the point of compliance wells are listed below (Figure 2):

- Production Wells - Wells PW-01, PW-02, and PW-03.
- Plant Fence Line - Wells TW-20, TW-34, TW-35, and TW-39.
- Southern Boundary - Wells TW-53, TW-54, TW-55, and Harris well. Mormon A Spring serves as a proxy for the Harris well, as discussed below.
- Soda Creek (surface water).

The Plant Fence Line wells are located inside the southern Plant fence line near Hooper Springs Road. The Southern Boundary wells are located within the Monsanto property boundary near its southern margin (about 1,200 ft south of the fence line). Mormon A Spring was identified as an alternate point of compliance for the Harris Well because the Harris Well may be completed within the transition zone between the UBZ and the LBZ, and not fully represent conditions in the UBZ (Golder 2001). For this reason, Mormon A Spring, located about 700 feet southwest of the Harris Well and also within the UBZ-1 region, has been identified as an alternate point of compliance location to evaluate groundwater quality in UBZ-1. The well and spring locations are shown in Figure 2 (UBZ wells and springs) and Figure 3 (LBZ wells).

Several sample locations have been established to monitor and evaluate spring and baseflow discharges to surface water (Soda Creek), and effects of discharges on surface water quality. With the exception of SC-4 (Soda Down) and Mormon A Spring, these sample locations are not point of compliance locations, but are used to evaluate water quality in Soda Creek. The sample locations for surface water quality are shown in Figure 4. Several surface water discharge points, including SC-1 (Soda Up), SC-4 (Soda Down), and SC-6 (Soda at the Property Line), along with Mormon A Spring as noted above, will also serve as key target areas for evaluating groundwater trends during implementation of this modeling work plan.

3.3 New Monitoring Wells Installed in 2011

CH2M Hill (2010) reviewed the 2009 groundwater conditions report (Golder 2011b) and identified several uncertainties in the conceptual hydrogeologic model of the site in UBZ-2, including the hydraulic nature of the Subsidiary Fault separating UBZ-1 and UBZ-2 west of the Plant, and areal distribution of the constituents of concern, particularly selenium, south and west of the Plant fenceline in UBZ-1 and UBZ-2. New monitoring wells installed in 2011 were designed to address these uncertainties. Eight new monitoring wells (TW-63 through TW-70, inclusive) were installed south and west of the Plant in June 2011 to help delineate the southern extent of the groundwater plume in UBZ-1 and UBZ-2 (Golder 2012a) and evaluate hydrogeologic conditions southwest of the Plant. The well locations are shown in Figure 2. The new wells were first sampled in July 2011, and have been added to the annual groundwater sampling program.

3.4 Current Status of Concentrations Compared to Remediation Goals

The following is a summary of the current status of constituent concentrations relative to RGs for the point of compliance locations (wells and surface water) located at the southern boundary or south of the Monsanto Plant. This information is presented in more detail in the 2011 Summary Report on Groundwater Conditions (Golder 2012a).

- Cadmium is below the remediation goal of 0.005 mg/L in the point of compliance locations in 2011 except in PW-01, PW-02, and TW-39. The 2011 cadmium concentrations in PW-01, PW-02, and TW-39 are 0.041 mg/L, 0.0107 mg/L, and 0.0157 mg/L, respectively. Cadmium is also above the remediation goal at Mormon A Spring (0.0143 mg/L).
- Fluoride is below the remediation goal of 4 mg/L in all point of compliance locations in 2011.
- Manganese is at or below the remediation goal of 0.18 mg/L in all point of compliance locations in 2011.
- Nitrate as N is below the remediation goal of 10 mg/L in all point of compliance locations in 2011 except in TW-20 (13.2 mg/L, average or two duplicate samples).
- Selenium is below the remediation goal of 0.05 mg/L in 2011 in point of compliance wells PW-02, PW-03, PW-04, TW-34, TW-35, TW-55, and in Soda Creek upstream and downstream of the effluent discharge. In 2011, selenium exceeds the remediation goal of 0.05 mg/L in point of compliance wells PW-01 (0.071 mg/L), TW-20 (0.116 mg/L; average of duplicate samples), TW-39 (0.489 mg/L), TW-53 (0.151 mg/L), TW-54 (0.240 mg/L; average of duplicate samples), and the Harris Well (0.209 mg/L). The selenium concentration of 0.338 mg/L in Mormon A Spring is also above the remediation goal.

Cadmium and selenium are the two constituents of concern with concentrations exceeding the remediation goals (RGs) at several point of compliance locations. In addition, sampling of new groundwater monitoring wells installed west of the Subsidiary Fault in 2011 and at the Monsanto Property line have concentrations of selenium above RGs. To the west of the Subsidiary Fault, cadmium concentrations are above the RGs.

4.0 GROUNDWATER MODELING GOALS

The work proposed in this plan is intended to support the current cycle of the Five-Year Review process for the Plant with consideration to several goals:

- The primary goal of this work is to re-evaluate the timeframe for concentrations of constituents of concern to decline below remediation goals (RGs) at points of compliance and other target locations focusing on the UBZ-1 and UBZ-2 zones.
- Additional data obtained in 2011 from new monitoring wells, combined with ongoing monitoring of existing points of compliance and other monitoring locations, have indicated that the previous modeling work conducted in support of the RI/FS process (Golder 1995) and updated as part of the 2003 Five-Year Review process (Golder 2008) does not adequately address current and future cadmium and selenium concentrations. This work plan is intended to provide an updated groundwater flow and contaminant transport model that can be use in the near term, but also for longer-term evaluations as needed based on ongoing data collection.
- The model will also provide a basis for developing a better understanding of the hydrogeology of the site. As part of this, an assessing of possible existing data gaps where more information may be needed to provide an estimate of future concentrations of constituents of concern.

The modeling will focus on future constituents of concern concentration trends at existing points of compliance and other key areas of interest, including but not necessarily limited to:

- Production Wells - Wells PW-01, PW-02, and PW-03.
- Plant Fence Line - Wells TW-20, TW-34, TW-35, and TW-39.
- Southern Boundary - Wells TW-53, TW-54, TW-55, and Harris well. Mormon A Spring serves as a proxy for the Harris well, as discussed below.
- Soda Creek (surface water), and in particular the SC-1 (Soda Up), SC-4 (Soda Down), and SC-6 (Soda at the Property Line) sampling locations, as well as Mormon A Spring.
- The eight new monitoring wells (TW-63 through TW-70, inclusive) installed south and west of the plant in June 2011.

5.0 MODELING APPROACH

The following section describes the general modeling approach to be used during implementation of this work plan. It is important to note that as the modeling work develops through the calibration process and additional insights are gained regarding the system, some refinements to this approach may be necessary.

To achieve the goals of the numerical model outlined above, the model will be constructed based on the existing conceptual understanding of the geologic framework, hydrostatigraphy, and groundwater flow system in the Plant vicinity. This includes incorporating our current understanding of the groundwater system based on our knowledge of:

- Area stratigraphy, focused on interpreting the spatial distribution of contacts between the UBZ and LBZ based on existing borehole data and the distribution of area faults.
- Hydraulic properties of the UBZ and LBZ available from existing slug and pump test data.
- Interpreted hydraulic behavior of the Monsanto and Subsidiary Faults.
- Regional and local groundwater flow patterns based on available water level data from monitoring wells.
- Current and historical distribution of concentrations of constituents of concern.
- Soda Creek flows derived from groundwater discharge at established monitoring points.
- Contaminant transport properties.
- Observed contaminant transport velocities.
- Estimates of groundwater recharge.

The modeling scenarios will use a calibrated steady-state groundwater flow field. Contaminant transport simulations will allow for transient simulations of contaminant migration for predictive scenarios based on the steady state flow field. The transport simulations will look at annual changes in concentrations, with the final length of the modeling period based on predictive times to attain RGs.

5.1 Selected Modeling Tools

Area stratigraphy will be prepared for input into the model using RockWorks (RockWare Earth Science and GIS Software), a subsurface data visualization and discretization tool. The groundwater flow model will be developed using the USGS MODFLOW-2005 software code, a widely accepted groundwater flow modeling tool (Harbaugh 2005). If available, the unstructured grid version (MODFLOW-USG) will be used to improve the representation of the fault properties in the model (Panday 2011). We will use Groundwater Vistas (Environmental Simulations Incorporated) as the groundwater model processing package to facility data input and output from MODFLOW.

Contaminant transport simulations will be completed using a compatible transport code with the selected version of MODFLOW. If MODFLOW-2005 is used, MT3DMS, a newer version of the MT3D model

(Zheng and Wang 1999), a widely-used contaminant transport code that links with the groundwater flow field generated by MODFLOW to allow contaminant transport to be simulated. MT3DMS differs from MT3D in that it allows for multi-species transport, supports additional solvers, and allows for cell-by-cell input of all model parameters.

Following construction of the numerical model, model calibration to current site conditions will be completed using a combination of trial-and-error adjustments to model parameters and through the use of inverse parameter estimation software, PEST (Doherty 2005). Once calibrated, the models can be used to forecast future conditions to reevaluate the timeframe for concentrations to decline below remediation goals (RGs) at points of compliance and other target locations.

5.2 Model Domain and Boundary Conditions

A schematic of the model investigation area is presented in Figure 5. The schematic represents initial development of the model boundaries based on a review of regional hydrogeologic conditions. Modifications to the model domain and the boundary conditions discussed below may occur during implementation of the work based on further refinement of the conceptual model and incorporation of site hydrostratigraphic data into the three-dimensional model.

Available hydrogeologic data are focused in the area near the Plant, with significantly more data available south of the Plant because work has targeted understanding the distribution of contaminants. The lack of discrete supporting data in areas away from the Plant results in some limitations on boundary and stratigraphic definition in these areas. This is a typical occurrence in many modeling situations, and this is handled by placing the boundaries at sufficient distance from the area of interest to allow generation of an appropriate regional flow field, with refinement through the calibration process in areas where more data are available.

The north boundary will be located approximately 4 miles north of the plant site in the Fivemile Meadows area. This will likely be a specified flux boundary to simulate regional groundwater flow from the north. The flux condition will be developed during initial model calibration based on an approximation of the regional water balance. The Blackfoot Reservoir, located about 12 miles north of the facility, is a significant area of groundwater recharge to areas south in the Soda Creek basin (Dion 1974), supporting use of a specified flux in this area to represent inflows to the aquifer system from the north.

The east boundary will coincide with the base of the Aspen Range, and will be represented by a specified flux boundary. It is known that significant recharge occurs along this fault at the base of this range from the uplands, including at Formation Spring, where spring discharge readily infiltrates into the Blackfoot Lava Field. Flux rates incorporated into the specified flux boundary will be estimated through an evaluation of the contributing watershed area in the Aspen Range combined with an estimate of appropriate recharge rates, as well as available information on Formation Spring inflows to the system.

The west boundary of the model will follow the base of the Ninety Percent Range, and along the eastern edge of the Alexander Reservoir. This boundary will be simulated as a specified flux along the Ninety Percent Range, based on evaluation of the contributing watershed area in the range combined with an estimate of appropriate recharge rates. This boundary may be adjusted during the calibration to also exclude explicit modeling of the Chester Hill area, because it is known to be composed of Quartzite and other non-basalt bedrock. A small portion of the boundary between the end of the range and Alexander Reservoir will initially be modeled as no flow, with the boundary assumed to be parallel to groundwater flow paths, and the edge of the reservoir will be modeled as a specified head boundary.

The south boundary will be represented by either a specified head or flux boundary representing flow out of the model toward the Bear River. The selection of this boundary condition will be set during the calibration process based on estimates of the water balance through the model domain.

The model base will follow the estimated base of the LBZ zone, and will generally be a no-flow boundary; however, known upwelling of sodic-rich water will need to be accounted for in the boundary as a flux input.

All of these boundaries are intended to be far enough away from the area of interest for contaminant transport that the model results will not be unduly controlled by the boundary effects provided an appropriate water balance is simulated through selection of the boundary values. This will be verified during the model calibration phase and refinements to the locations of boundaries and selection of specific boundary conditions may be implemented to develop a representative model.

5.3 Groundwater Extraction and Seep, Spring, and Surface Water Discharges

The Plant's four pumping wells will be explicitly incorporated into the plant as pumping wells. PW-01, PW-02, PW-03, and PW-04 remove a combined volume of approximately 2200 gallons per minute (gpm) of groundwater on average, respectively.

Individual seeps and springs will be incorporated into the model as drain cells to provide model calibration comparisons with measured seep and spring flows. Recent data on seep and spring flows are summarized in Table 13 of the most recent 2011 Summary Report on Groundwater Conditions (Golder 2012a). Recent and historical information will both be considered in setting specific seep and spring discharge rates. Diffuse groundwater flow into Mormon Creek and Soda Creek will also be incorporated into the model through drain cells.

Ledger Spring, the water source for the City of Soda Springs, will also be explicitly incorporated into the model based on estimated or measured spring flows.

5.4 Hydraulic Conductivity

Hydraulic conductivity tests have been conducted at many wells, as summarized in Table 5-1. This information is derived from three previous reports presenting hydraulic conductivity testing (Golder, 1995, 2007, and 2012b). Hydraulic characterization has also been performed at the adjacent Kerr McGee site. During model calibration, the spatial distribution of these results will be reviewed, and evaluated. These data will be used to constrain the range of values for hydraulic conductivity allowed in model calibration. The tests are focused in the area around the plant, and inferences will be made regarding hydraulic conductivity values elsewhere in the model area. A detailed summary of hydraulic test information will be presented as part of documentation in the modeling report.

Table 5-1: Summary of Monsanto Single Well Hydraulic Conductivity Testing for UBZ and LBZ

Zone	Number of Wells Tested	Number of Tests	Hydraulic Conductivity (feet/day)		
			Minimum	Maximum	Geometric Mean
UBZ-1	6	13	0.7	530	31.0
UBZ-2 (with TW-58 pumping test data)	7	19	0.3	7,808	91.9
UBZ-2 (without TW-58 pumping test data)	6	15	0.3	676	42.4
UBZ-3	13	21	0.04	340	15.9
LBZ-1	3	5	0.5	33	5.4
LBZ-2	1	2	0.4	0.5	0.4
LBZ-3	4	8	8.0	96	25.8
LBZ-4	1	1	0.04		

5.5 Effective Porosity

Effective porosity is expected to vary between permeable interflow zones and low permeability flow interiors. The sensitivity to effective porosity will be evaluated during model calibration. Expected effective porosity values for interflow zones range from approximately 15 to 30 percent, with between 0.1 and 1 percent for fractured rock expected for the flow interiors. References will be provided for the values selected.

5.6 Groundwater Levels

Groundwater levels are routinely collected and summarized as part of annual monitoring. The most recent groundwater levels are presented in Figures 6 and 7, and were summarized in the 2011 Summary of Groundwater Conditions (Golder 2012a), including hydrographs in Appendix I of that report. The existing historical Monsanto and Kerr McGee groundwater datasets will be used to establish specific calibration targets during the modeling process. The datum for the Kerr McGee wells will be confirmed prior to use to ensure consistency with the Monsanto site datum.

5.7 Source Areas

There are three documented source areas that will be included in the contaminant transport simulations. They are:

- Old Underflow Solids Ponds (UBZ-2)
- Northwest Pond (UBZ-4)
- Old Hydroclarifier (UBZ-4)

Additional details on these source areas including a description of the closure of each, is included in Golder (1995). A focused source area characterization study is being implemented (Golder 2011b), and the number of source areas and understanding of chemical loading may be updated as a result of these investigations. These source areas are shown in Figure 8.

A statistical evaluation of concentration trends in these areas was completed as part of the five-year review process (Golder 2003, 2008). The last five-year review cycle, the 2008 five-year review included a statistical analysis of the data collected between 1991 and 2007. This work will be considered, along with more recent data summarized in Appendices A and E of the 2011 Summary of Groundwater Conditions report, in defining the source areas and calibrating the existing distribution of constituents of concern from the source areas.

Closure of the on-site sources supported the selection of monitored natural attenuation with institutional controls in the ROD. While cadmium concentrations were relatively stable until 2007, recent data indicates that cadmium has recently been increasing in portions of the site. This increase has been attributed to use of magnesium chloride as a dust suppressant, as the chloride introduced to the subsurface during groundwater recharge can mobilize cadmium. Use of magnesium chloride for dust control has ceased, but chloride concentrations remain elevated in some source areas and will be evaluated as part of the modeling effort. Attenuation and mobilization processes for constituents of concern will be considered and incorporated into the model as appropriate.

Although generally decreasing (Golder, 2012a) there are a few locations where selenium concentrations have been rising over the last few years in the source areas, for example at test well (TW-16) by the

Northwest Pond at TW-24 near the Old Underflow Solids Ponds. These trends may be due to annual variations in precipitation. More investigation of possible reasons for this will be part of the source area characterization that is in progress. Selenium will likely be modeled as a conservative constituent in the model (i.e., no adsorption reactions will be included in the transport calculations), based on typical behavior documented in field and laboratory studies (EPA 2007). In addition, nitrate will also be modeled as a conservative parameter. Distribution coefficients (K_d) values for other constituents of concern will be chosen based on available literature values (Golder 2011a), and may be adjusted during modeling based on model results and on conclusions from the source area characterization study currently being implemented. Conclusions from the source area characterization study will also be used as part of the model calibration and prediction of future concentrations and trends.

5.8 Model Calibration and Predictive Simulations

Model predictions are uncertain and groundwater flows are affected by the spatial variation of hydrostratigraphic conditions, hydrogeologic properties, and other factors affecting the water balance of the system, such as recharge and discharge. We plan to use a probabilistic approach to assess potential impacts on environmental receptors. This entails the use of nonlinear parameter estimation techniques during model calibration. Model outputs will comprise a probabilistic estimate of the groundwater contamination plume migrating off site or to specific environmental receptors. This approach will identify the uncertainty and sensitivity of model predictions.

The groundwater model will be calibrated to groundwater levels as recorded in groundwater monitoring wells across the site and observations of contaminant migration. A steady-state groundwater model with conservative contaminant migration velocities will be developed to simulate the current conditions at the site. Using both the groundwater elevations and contaminant transport observations allows the model parameters to be constrained by all of the observation data resulting in better model predictions. Consideration of spring flow discharges and the existing Plant production wells will also be considered in the steady state calibration.

The initial model set up will include approximate calibration by assigning site-specific values and a few “trial-and-error” model runs. The outcome of this phase will be a groundwater model that is ready to be calibrated to groundwater levels and conservative contaminant transport.

Once the initial model has been set up, Golder will carry out nonlinear parameter estimation to more thoroughly determine appropriate model parameters. Golder will use the software, PEST, to determine the optimum parameter set that minimizes the error between the model and the calibration data. Calibration parameters are expected to include hydraulic conductivity, recharge/infiltration, stream, seep, and spring conductance. Golder may also use the “Pilot Point” approach (Doherty 2003) to assign hydraulic conductivity in the model. This approach is suitable where spatial variation of hydraulic conductivity occurs within a geologic unit, such as basalt flows. The potential benefit of this methodology will be assessed after the development of the initial groundwater model.

Once the model is matched to calibration data, PEST will be used to vary model parameters in such a way that the model maintains calibration, but includes different sets of hydraulic parameters for each lithological unit. The input parameters will be varied within a defined range, which will be comparable to the hydraulic tests and observed transport velocities from the site. The outcome of this phase will be a range of groundwater models, each containing different hydraulic parameters but each calibrated to the observations at the site. This approach takes into account the non-unique characteristics of groundwater flow and transport models.

Each of the calibrated models will be used to complete predictive simulations of contaminant transport. The outcome of the suite of paired groundwater flow and contaminant transport models will provide a probabilistic prediction of contaminant concentrations through time. The model will be developed to simulate migration over time to support evaluation of the timeframe for concentrations to decline below remediation goals (RGs) at points of compliance and other important target locations.

6.0 REPORTING AND SCHEDULE

Following completion of the modeling work, methods, assumptions, and conclusions from the modeling work will be summarized in a report.

The following schedule is proposed for this work.

- Draft Work Plan Submitted to EPA (April 2012)
- EPA Review and Approval of Work Plan (April and May 2012)
- Final Work Plan (July 2012)
- Detailed data evaluation and conceptual model (July 2012)
- Construct and develop MODFLOW flow model (August – October 2012)
- Construct and develop contaminant transport and run predictive scenarios (November and December 2012)
- Report on modeling with conclusions regarding natural attenuation (December 2012 to February 2013)
- Final Report (February 2013)

7.0 CLOSING

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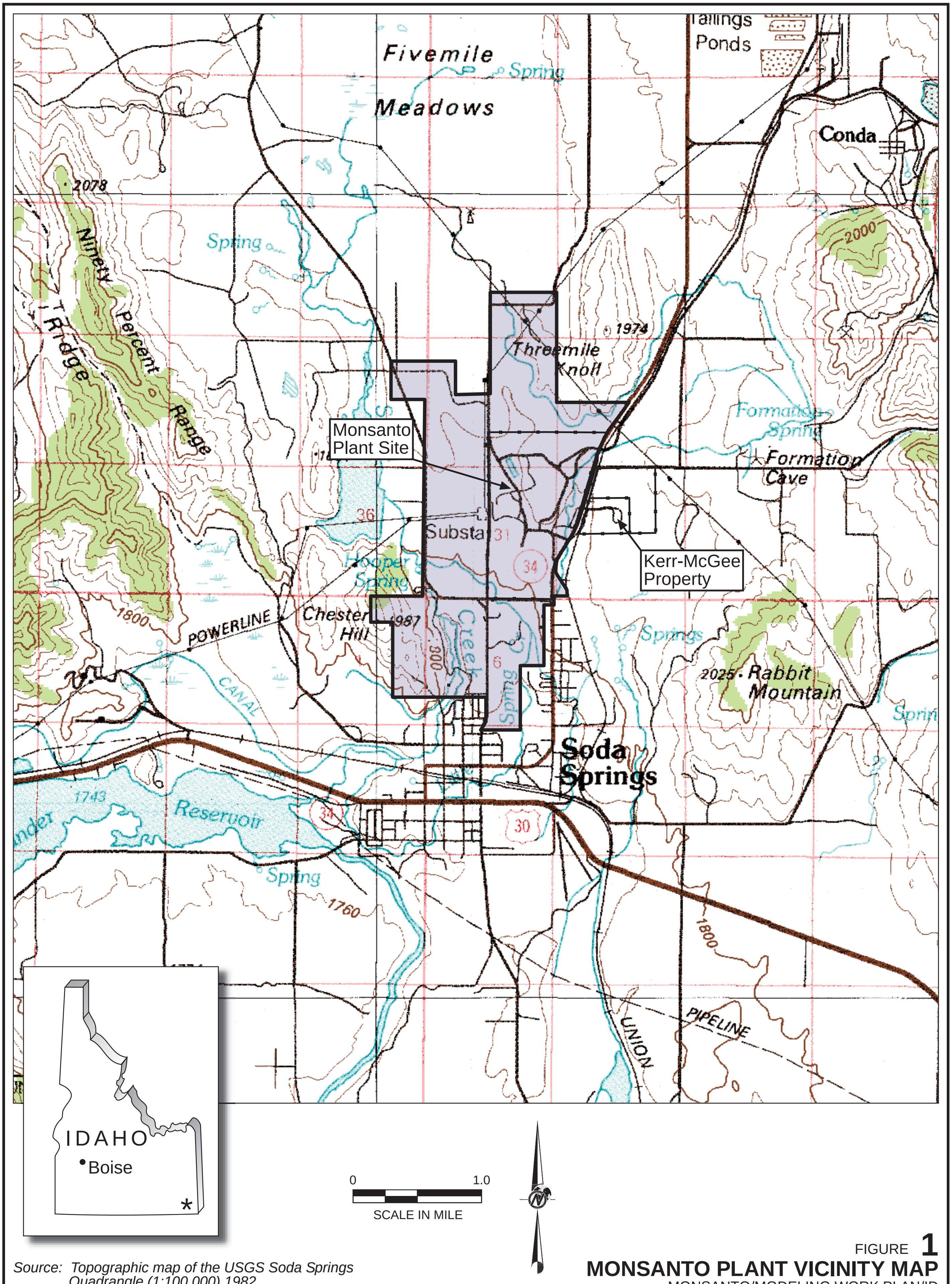
FIGURES



Source: *Topographic map of the USGS Soda Springs Quadrangle (1:100,000) 1982.*

FIGURE 1

MONSANTO PLANT VICINITY MAP

MONSANTO/MODELING WORK PLAN/ID

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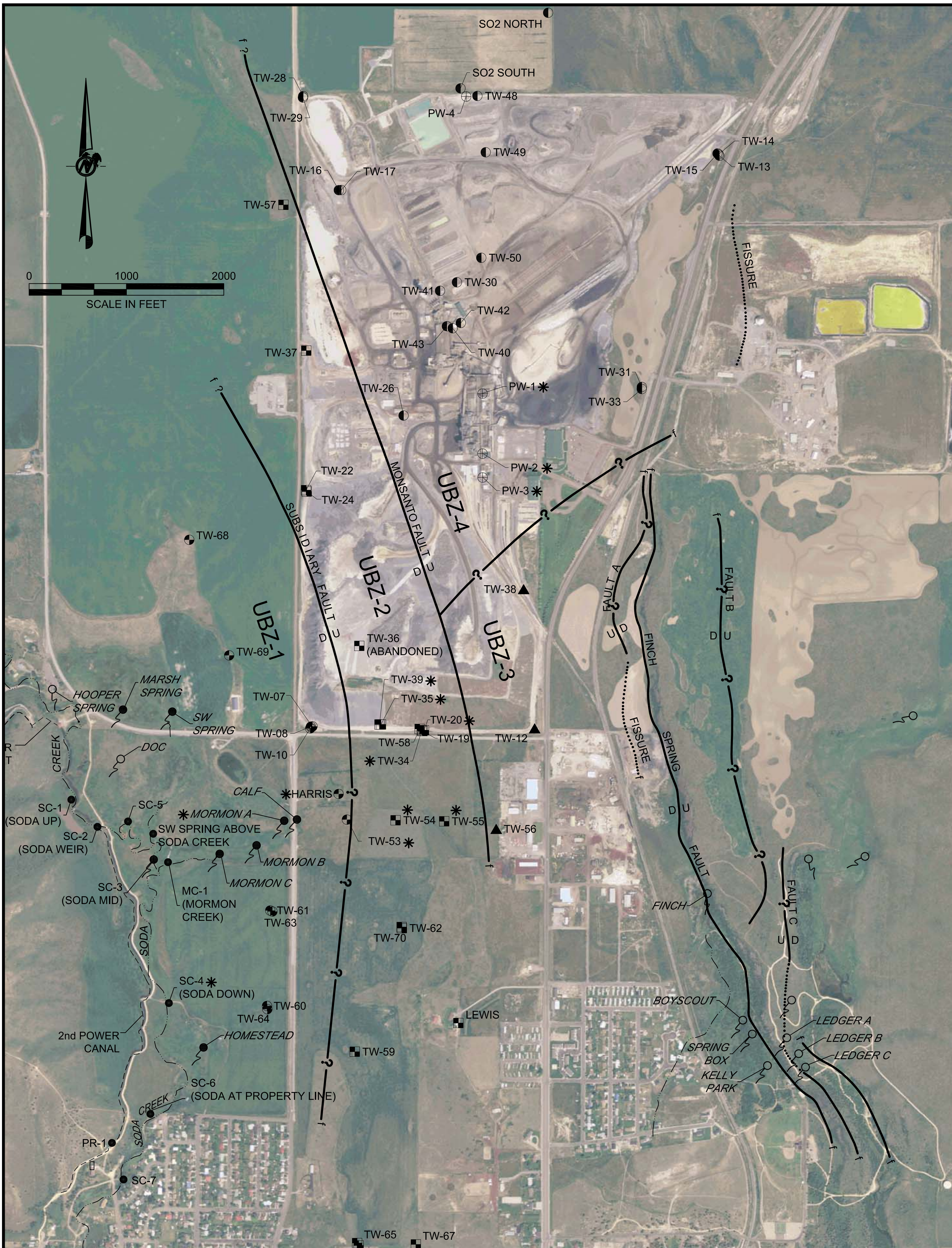

LEGEND:

f U D f	FAULT	TW-60	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-1	*MORMON A*	SPRING LOCATION WITH NAME (WHERE KNOWN)
f U ? D f	FAULT (INFERRED)	LEWIS	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-2	*DOC*	SPRING LOCATION (NOT SAMPLED) WITH NAME (WHERE KNOWN)
f .... f	FISSURE	TW-56	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-3	*MORMON CREEK*	SURFACE WATER LOCATION WITH NAME
UBZ-1	GROUNDWATER ZONE	TW-33	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-4		
		PW-1	PRODUCTION WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-4		
		✳	POINT OF COMPLIANCE LOCATION		

FIGURE **2**

LOCATION OF SPRINGS AND WELLS IN THE UPPER BASALT ZONE

MONSANTO/MODELING WORK PLAN/ID

SOURCE:
AERIAL PHOTO FROM MONSANTO (5/2/2003).
SITE TOPOGRAPHY FROM AERIAL MAPPING, INC., IDAHO (5/11/1996).

LEGEND:

f —U/D— f	FAULT
f —U/D ?— f	FAULT (INFERRED)
f ········ f	FISSURE
LBZ-1	GROUNDWATER ZONE
TW-09	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE LBZ-1
TW-21	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE LBZ-2
▲ TW-11	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE LBZ-3
TW-44	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE LBZ-4
PW-1	PRODUCTION WELL LOCATION WITH NAME
✳	POINT OF COMPLIANCE LOCATION
MORMON A	SPRING LOCATION WITH NAME (WHERE KNOWN)
DOC	SPRING LOCATION (NOT SAMPLED) WITH NAME (WHERE KNOWN)
● *MORMON CREEK*	SURFACE WATER LOCATION WITH NAME

FIGURE **3**

LOCATION OF WELLS IN THE LOWER BASALT ZONE

MONSANTO/MODELING WORK PLAN/ID

SOURCE:
AERIAL PHOTO FROM MONSANTO (5/2/2003).
SITE TOPOGRAPHY FROM AERIAL MAPPING, INC., IDAHO (5/11/1996).

FIGURE 4
SODA CREEK AND SPRING SAMPLE LOCATIONS
MONSANTO/MODELING WORK PLAN/ID

SOURCE: AERIAL PHOTO FROM USDA-NATIONAL AGRICULTURAL IMAGERY PROJECT (NAIP), 2009

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LEGEND:

APPROXIMATE MODEL DOMAIN AREA

SOURCE: AERIAL PHOTO FROM GOOGLE EARTH, 2011

0 5000 10000

SCALE IN METERS

FIGURE **5**

SCHEMATIC OF APPROXIMATE MODEL DOMAIN

MONSANTO/MODELING WORK PLAN/ID

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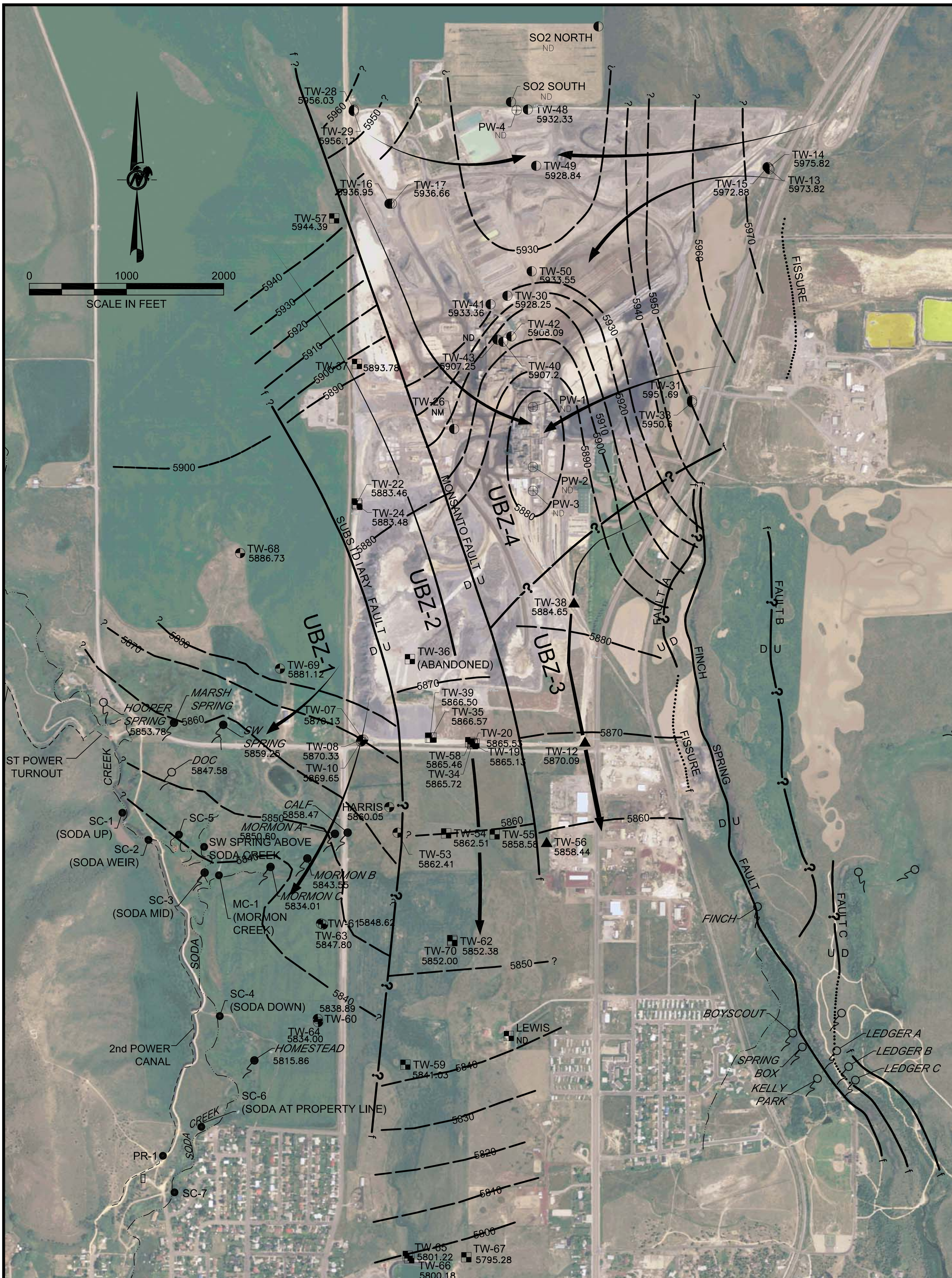

LEGEND:

f — U — f	FAULT
f — U ? D — f	FAULT (INFERRED)
f ········ f	FISSURE
UBZ-1	GROUNDWATER ZONE
←	GROUNDWATER FLOW DIRECTION
— 5840 —	GROUNDWATER CONTOUR (10 FOOT INTERVAL)
MORMON A	SPRING LOCATION WITH NAME (WHERE KNOWN)
DOC	SPRING LOCATION (NOT SAMPLED) WITH NAME (WHERE KNOWN)
MORMON CREEK	SURFACE WATER LOCATION WITH NAME
TW-60 5837.68	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-1
TW-59 5839.05	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-2
TW-56 5853.05	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-3
TW-28 5948.04	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE UBZ-4
PW-1 ND	PRODUCTION WELL LOCATION WITH NAME

GROUNDWATER ELEVATION (FEET) WITH QUALIFIER (IF ANY)
ND = NO DATA

SOURCE:
AERIAL PHOTO FROM MONSANTO (5/2/2003).
SITE TOPOGRAPHY FROM AERIAL MAPPING, INC., IDAHO (5/11/1996).
WELL LOCATIONS BY GOLDER ASSOCIATES, (12/12/2001).

FIGURE 6

GROUNDWATER ELEVATION IN THE UPPER BASALT ZONE (MAY 2011)

MONSANTO/MODELING WORK PLAN/ID

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LEGEND:

f —U/D— f	FAULT	MORMON A	SPRING LOCATION WITH NAME (WHERE KNOWN)	TW-60 5837.68	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE LBZ-1
f —U/D ?— f	FAULT (INFERRED)	DOC	SPRING LOCATION (NOT SAMPLED) WITH NAME (WHERE KNOWN)	TW-59 5839.05	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE LBZ-2
f ······ f	FISSURE	MORMON CREEK	SURFACE WATER LOCATION WITH NAME	TW-11 5866.39	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE LBZ-3
LBZ-1	GROUNDWATER ZONE			TW-18 5934.80	MONITORING WELL LOCATION WITH NAME IN GROUNDWATER ZONE LBZ-4
	GROUNDWATER FLOW DIRECTION		GROUNDWATER ELEVATION (FEET) WITH QUALIFIER (IF ANY)	PW-4 ND	PRODUCTION WELL LOCATION WITH NAME
— 5900 —	GROUNDWATER CONTOUR (10 FOOT INTERVAL)		ND = NO DATA		

SOURCE:
AERIAL PHOTO FROM MONSANTO (5/2/2003).
SITE TOPOGRAPHY FROM AERIAL MAPPING, INC., IDAHO (5/11/1996).
WELL LOCATIONS BY GOLDER ASSOCIATES, (12/12/2001).

FIGURE 7

GROUNDWATER ELEVATION IN THE LOWER BASALT ZONE (MAY 2011)

MONSANTO/MODELING WORK PLAN/ID

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LEGEND:

MONSANTO PROPERTY BOUNDARY (APPROXIMATE)

PLANT PERIMETER FENCE

CREEK / IRRIGATION DITCH

FACILITY AREA

ORIGINAL SOURCE AREA

SOURCE:
AERIAL PHOTO FROM MONSANTO (5/2/2003).
SITE TOPOGRAPHY FROM AERIAL MAPPING, INC., IDAHO (5/11/1996).
WELL LOCATIONS BY GOLDER ASSOCIATES, (12/12/2001).

FIGURE **8**

MONSANTO FACILITY MAP

MONSANTO/MODELING WORK PLAN/ID

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Golder Associates

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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